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Brine-phase spiking during CO2 injection at the Ketzin site, Germany

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Tracer tests are an indispensable tool for characterizing georeservoirs with a view at geotechnical uses like nuclear waste disposal, CO_2 storage, or geothermal energy extraction. They provide the only means of determining the fluid residence time (i. e., the size of the reservoir) under a given flow regime. Further, single-well tracer push-pull (injection-withdrawal) tests provide the best method for quantifying fluid-rock contact surface areas, which play an important role in water-rock interactions, dissolution/precipitation, heat exchange, matrix diffusion and sorption processes, and thereby also in CO_2 trapping by various mechanisms.

Within the CO_2 long-term injection experiment <www.co2sink.org> being conducted at the Ketzin site in Germany since 2008, two liquid-phase organic tracers were introduced into the reservoir brine prior to the beginning of CO_2 injection; the spiked brine was separated from the CO_2 plume by a negligibly-sized liquid chaser slug. This kind of brine-phase spiking is intended to quantify the passive displacement of reservoir brines by the injected CO_2. The very low values of brine-phase tracer concentrations sampled in various depths at two observation holes (in 50 m and 100 m distance from the injection hole), amounting to less than 10^{-7} of their values at the injection hole, are consistent with the predictions of numerical (semi-analytical) simulations of tracer breakthrough signals in a radially-symmetric, immiscible-flow approximation (which is acceptable for early times of CO_2 plume spreading). Values of brine-phase tracer mass recovery cannot be estimated from this experiment, because brine flow rates cannot be measured at observation holes under the passive downhole sampling conditions provided by the Ketzin experiment setup. In contrast with that, the CO_2 transport experiment to be conducted at the Heletz site in Israel within the MUSTANG project <http://www.co2mustang.eu/Heletz.aspx>, under forced-gradient dipole conditions, will ensure well-defined discharge values for both the liquid and the gas phase, thus also enabling mass recovery estimates.

The time schedule and operational constraints of the Ketzin experiment did not allow to conduct single-well push-pull tests prior to CO_2 injection. However, after a longer shut-in period following CO_2 injection, it may become possible to perform mixed-phase sampling at the former injection hole. Since the brine-phase tracer will largely remain concentrated around this hole, (i) most of it being dissolved in the reservoir brine, (ii) part of it having diffused into reservoir rock, maybe also sorbed onto rock surfaces, (iii) part of it having dissolved into supercritical CO_2 (as far as supercritical conditions will have prevailed), and (iv) part of the latter having moved away from the injection hole along with the CO_2 plume, this kind of 'push-pull' experiment could provide interesting information about fluid-rock and brine-CO_2 interface areas.

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